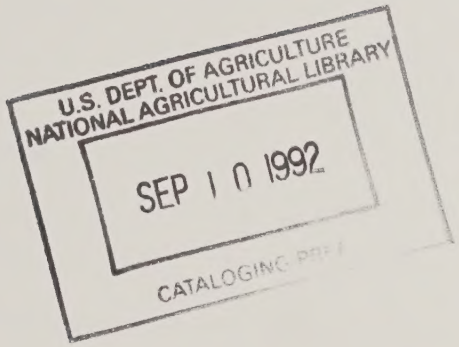
VEGETABLES WEST

FUNGICIDE BENEFITS ASSESSMENT

National Agricultural Pesticide Impact Assessment Program (NAPIAP)



FUNGICIDE BENEFITS ASSESSMENT

VEGETABLES - WEST

January, 1991

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This Report Represents a Portion of the USDA/States
National Agricultural Pesticide Assessment Program (NAPIAP)
Fungicide Assessment Project

Table of Contents

PREFACE

Plant diseases affect all the major food crops world-wide and must be controlled to prevent significant production losses and maintain food quality for animals and humans. In addition, fungicides are a necessary factor in maintaining the availability of fiber and landscape improvements ranging from forest management to enhancements through the use of ornamentals. Agricultural fungicides are a significant component in effective disease control and are critical to plant health management systems. Fungicides provide benefits to producers as well as consumers and to local as well as national economies. Farmers benefit from the prevention of yield losses, improved crop quality, enhanced market opportunities, facilitation of farmwork and harvest. Consumers also benefit from an ample, varied, safe, healthy and inexpensive food supply that is available throughout the year.

This is one of 11 separate reports that assessed the beneficial aspects of fungicide use in U.S. agriculture. The 11 reports, all using a commodity approach in evaluating fungicide use, comprise the Fungicide Benefits Assessment. This assessment represents one part of the USDA/States National Agricultural Pesticide Impact Assessment Program's Fungicide Assessment Project. The two other parts deal with (a.) a treatise examining the health and environmental factors associated with the agricultural use of fungicides, and (b.) an assessment of the status as well as the management strategies for fungal resistance to fungicides in the U.S.

The 11 Fungicide Benefits Assessment reports were prepared by a team of scientists (team leaders). The team leaders and the listing of their reports (by commodity) in the Fungicide Benefits Assessment are as follows:

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Introduction

In order to accurately assess the importance of fungicides to U. S. agriculture, the National Agricultural Pesticide Impact Assessment Program initiated a program to provide benefits information on the major fungicides used in U. S. agriculture.

This survey includes fungicide use on vegetables grown west of the Mississippi River. Minor crops (less than 100-200 acres) may be excluded in individual states. Seed treatments may or may not be included.

Background Statement

This report is organized by commodity and states, followed by individual diseases. Generally, fungicides used on each crop are listed next to individual diseases. However, some responders chose to lump similar diseases.

The number of applications refers to treated acreage, e.g., if the total acres of a crop is 1,000 and 10% of that receives 2 applications, then 100 acres is treated with 2 applications of a fungicide. The relative frequency use is found under "Acres treated",--if 50% of the acreage (e.g. 1,000 acres) is treated and fungicide A is used 90% of the time and fungicide B is used 10% of the time, then A is applied to 450 acres and B is applied to 50 acres. Fungicides are occasionally used in combination and their combined total may then be greater than 100.

The column "% yield loss without fungicides" is the estimated crop loss without any fungicides. The last column indicates the relative efficacy of each fungicide.

The vast majority of this survey is based on "best guesses" by Cooperative Extension personnel who are familiar with vegetable production in their area. These data are not hard facts, but represent a close estimation by experts in the field of plant pathology. The production acreage of an individual crop, the specific diseases, chemical used, and number of applications are probably fairly accurate. The percentage of production acres treated is no doubt a reasonable estimation but the last two categories, percent yield loss without fungicides and expected yield loss using specific fungicides, are very difficult to estimate since conditions are so variable from one year to another. Yield losses generally are averages over many years but the reader should realize that there exists a tremendous range of variability. The last category, expected yield loss using specific fungicides, probably has the lowest degree of accuracy. Much of the data in this category was generated by only a few cooperators, and I assume responsibility for most of it.

Rates of fungicides are not included because all responders listed labeled rates in that category.

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ASPARAGUS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
CA	40,000	Phytophthora Root Rot				2	
			Metalaxyl	1	2-5		0-1
			Fosetyl-Al	1	Trace		0-1
					5-10 Total	2-5	
		Rust	Mancozeb	2-3	40		
		Cercospora Leaf Spot	Triforine	2-3	40		
			Sulphur	1-2	20		
WA	31,000	Rust	Mancozeb	1	5		
		Fusarium Crown Rot	Benomyl	1	70-90	50-70	

BEANS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
					0-30 Total	0-30	
AR	1,800	Rust	Maneb	0-2	60		0-5
		White Rot	Benomyl	0-2	40		0-5
		Bacterial Blight	Copper	0-2	0-30	0-30	0-15
					90 Total	2-20	
CA	74,000	Damping Off	Thiram (Seed)	1	50		0-5
			Captan (Seed)	1	50		0-5
			Metalaxyl (Seed)	1	40		0-2
		Stem Canker			90 Total	5-25	
			Chloroneb (Seed)	1	50		0-5
			PCNB (Seed)	1	50		0-10
		White Mold			1-3 Total	<1	
			Benomyl	1	50		0-<1
			Thiophanate methyl	1	50		0-<1
CO	175,000	Pythium			50-100 Total	0-20	
		Fusarium	Carboxin (Seed)	1	30		0-3
		Rhizoctonia	Captan (Seed)	1	50		0-5
			Thiram (Seed)	1	50		0-5
			Metalaxyl (Seed)	1	30		0-2
		Pseudomonas Xanthomonas	Copper	1-3	20-50	0-20	0-10
		Rust			50 Total	20	
		Sclerotinia	Chlorothalonil	1-3	15		0-5
			Maneb	1-3	60		0-5
			Benlate	1-3	10		0-5
			Iprodione	1-3	10		0-5
			Thiophanate methyl	1-3	5		0-5

BEANS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
HI	160	Powdery Mildew	Sulphur	4	95	100	
		Cercospora Leafspot			95 Total	100	
		Anthracnose	Benomyl	4			
			Maneb	4			
			Botran	4			
ID	190,000	Damping Off	Captan (Seed)	1	80	5	0-2
		White Mold			20 Total	5	
			Benomyl	1	40		0-2
			Thiophanate methyl	1	40		0-2
			Iprodione	1	20		0-2
		Root Rots			100 Total	5	
			Captan (Seed)	1	80		0-2
			Carboxin (Seed)	1	20		0-2
LA	400	White Mold			50 Total	25	
		Rust	Chlorothalonil	3	33		0-10
		Rhizoctonia Aerial	Maneb	3	33		0-10
		Blight	Benomyl	3	33		0-10
MN	1,700	Alternaria Leaf Blight	Maneb	2-4	80		
ND	423,000	Rust	Maneb	1	48	4	0-2
		White Rot			52 Total	3	
			Benomyl	1	15		0-2
			Thiophanate methyl	1	85		0-2
UT	4,500	White Mold	Benomyl	1	25	5-10	0-5

CARROTS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
CA	25,000	Alternaria or Cercospora Leaf Blight			50-60 Total	10-20	
			Mancozeb	2-3	50		0-5
			Maneb		10		0-5
			Chlorothalonil		30		0-5
			Iprodione		10		0-5
		Damping Off			100 Total	0-5	
			Captan (Seed)	1			0-2
			Thiram (Seed)	1			0-2
		Powdery Mildew	Sulphur	2	20-30	2-5	0-2
		White Mold			5-15 Total	1-2	
			Dicloran	2	60		0-0.1
			Benomyl	2	40		0-0.1
CO	1,500	Damping Off			100 Total	0-5	
			Captan (Seed)	1	50		0-2
			Thiram (Seed)	1	50		0-2
		Alternaria or Cercospora Leaf Blight and White Mold			75 Total	10	
			Mancozeb	3-5	20		0-5
			Maneb	3-5	20		0-5
			Iprodione	3-5	20		0-5
			Copper	3-5	20		0-5
			Chlorothalonil	3-5	20		0-5
ID	600	Damping Off			100 Total	0-5	
			Captan (Seed)	1	50		0-2
			Thiram (Seed)	1	50		0-2
MN	1,700	Alternaria Leaf Blight	Mancozeb	2-4	80		

CARROTS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
OR	1,000	Alternaria or Cercospora Leaf Blight	Mancozeb	1-2	20	5-20	0-5
TX	10,300	Cercospora or Alternaria Leaf Blight			50-100 Total	10-40	
			Mancozeb	1-4	30		0-5
			Maneb	1-4	20		0-5
			Chlorothalonil	1-4	25		0-5
			Copper	1-4	15		5-20
			Triphenyltin Hydroxide	1-4	10		0-10
		Damping Off			100 Total	0-5	
			Captan (Seed)	1	40		0-2
			Thiram (Seed)	1	60		0-2
WA	5,600	Damping Off			100 Total	20	
			Captan (Seed)	1	50		5-10
			Thiram (Seed)	1	50		5-10
		Leaf Blight			100	10	
			Maneb	2-4	40		<2
			Mancozeb	2-4	40		<2
			Iprodione	2-4	20		<2

CELERY

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
CA	22,000	Late Blight			90 Total	25-50	
			Chlorothalonil	3-4	30		0-10
			Anilazine	3-4	30		0-10
			Thiophanate methyl	3-4	10		0-10
			Benomyl	3-4	30		0-10
		Pink Rot	Dicloran	1	25	10-15	
TX	1,900	Late Blight, Cercospora Blight			70-100 Total	50-100	
			Chlorothalonil	3-6	30		0-10
			Anilazine	3-6	5		0-10
			Thiophanate methyl	3-6	5		0-10
			Benomyl	3-6	5		0-10
			Copper	3-6	5		0-10
			Maneb	3-6	20		0-10
			Mancozeb	3-6	30		0-10

CRUCIFERS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
AZ	10,400	Downy Mildew	Chlorothalonil and Metalaxyl	2-3	55	5-20	
CA	151,000	Downy Mildew					
			Chlorothalonil and Metalaxyl	1-3	20-40 Total 40	5-15	 0-2
			Chlorothalonil		30		0-5
			Maneb		30		0-5
		Damping Off, Basal Stem Rot	Metalaxyl	1	<0.1	<0.1	
CO	1,000	Damping Off					
			Captan (Seed)	1	90-100 Total 50	0-10	 0-5
			Thiram (Seed)	1	50		0-5
		Pythium	Metalaxyl	1-2	5-50	5-15	5
		Downy Mildew	Chlorothalonil	3-7	90	15	5
		Xanthomonas	Copper	3-7	5-50	15	5-10

CRUCIFERS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
HI	1,530	Downy Mildew			70-100 Total	10-85	
		Alternaria	Maneb	3			
		Cercospora	Chlorothalonil	3			
		Rhizoctonia	Iprodione	3			
		Sclerotinia	Metalaxyl	3			
		Ascochyta					
			Copper	3			
			PCNB	3			
LA	1,100	Downy Mildew			25 Total	10	
		Alternaria Leaf Spot	Maneb	2	20		0-5
			Metalaxyl	2	20		0-5
			Metalaxyl and Chlorothalonil	2	60		0-5
MN	500	Downy Mildew	Chlorothalonil	2-4	50		

CRUCIFERS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
OK	1,000	Downy Mildew			75 Total	+50	
			Chlorothalonil and Metalaxyl	4	80		0-5
			Chlorothalonil	4	10		0-10
			Maneb	4	10		0-10
		Alternaria Leaf Spot			50 Total	50	
			Chlorothalonil	4	95		10
			Maneb	4	5		15
OR	8,000	Downy Mildew	Chlorothalonil	1-2	50	5-20	0-5
TX	14,000	Downy Mildew			50-100 Total	5-25	
			Chlorothalonil and Metalaxyl	2-4	30		0-2
			Chlorothalonil	2-4	25		0-5
			Maneb	2-4	40		0-5
			Copper	2-4	5		0-10
		Alternaria			50-100 Total	5-25	
			Chlorothalonil	2-4	50		0-5
			Maneb	2-4	50		0-5

CUCURBITS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
AZ	5,000	Powdery Mildew			75 Total	10-30	
			Sulphur	2-3	50		0-10
			Triadimefon	2-3	50		0-10
		Downy Mildew	Metalaxyl	2	75 Total	5-20	0-10
AR	2,000	Anthracnose			60 Total	5-40	
			Mancozeb	1-4	50		0-10
			Benomyl	1-4	50		0-10
		Powdery Mildew			60 Total	5-40	
			Triadimefon	1-4	50		0-10
			Benomyl	1-4	50		0-10
		Gummy Stem Blight	Mancozeb	1-4	20-60	5-40	5-10
CA	146,000	Powdery Mildew			25 Total	5-10	
			Sulphur	1-2	30		0-2
			Triadimefon	1-2	40		0-2
			Benomyl	1-2	30		0-2
		Damping Off, Root Rot	Metalaxyl	1	12-15 Total	<2	0-1
CO	1,000	Damping Off			100 Total	5	
			Captan (Seed)	1	50		0-2
			Thiram (Seed)	1	50		0-2
		Pseudomonas	Copper	1-3	25	10	5
		Cercospora, Powdery Mildew	Benomyl	1-3	25	10	0-5
HI	1,158				100 Total	80	
		Alternaria	Triadimefon	3-8			
		Cercospora	Benomyl	3-8			
		Didymella Blight	Chlorothalonil	3-8			
		Pythium	Maneb	3-8			
		Powdery Mildew	Mancozeb	3-8			
		Anthracnose	Copper	3-8			

CUCURBITS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
ID	800	Damping Off	Captan (Seed)	1	80	20	0-5
IA	500	Powdery Mildew Anthracnose Alternaria Leaf Spot	Chlorothalonil	1-3	100	30	5-10
		Downy Mildew			100 Total	5-30	
			Maneb	1-3	50		0-10
			Mancozeb	1-3	50		0-10
KS	7,000	Anthracnose			70 Total	5-15	
			Chlorothalonil	1-2	40		0-5
			Mancozeb	1-2	60		0-5
		Powdery Mildew	Triadimefon	1-2	70	5-15	0-5
LA	5,000				50 Total	60	
		Belly Rot (Rhizoctonia)	Chlorothalonil	2-4			15-25
		Gummy Stem Blight Anthracnose	Mancozeb	2-4			15-25
		Downy Mildew Powdery Mildew	Metalaxyl and Chlorothalonil	2-4			10-20

CUCURBITS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
MO	11,000	Anthracnose			75 Total	50+	
			Benomyl	4	20		0-10
			Mancozeb	4	40		0-10
			Maneb	4	40		0-10
		Downy Mildew			75 Total	50+	
			Mancozeb	4	50		0-10
			Maneb	4	50		0-10
		Pythium, Phytophthora	Metalaxyl	1-2	75 Total	20-40	2-20
		Gummy Stem Blight			75 Total	50	
			Chlorothalonil	2	40		5-10
			Mancozeb	2	30		5-10
			Maneb	2	30		5-10
		Powdery Mildew	Benomyl	4	75	20-50	5-20
NB	1,700	Anthracnose			80 Total	50-60	
			Benomyl	1-3	30		0-10
			Chlorothalonil	1-3	30		0-10
			Mancozeb	1-3	40		0-10
		Powdery Mildew	Benomyl	1-3	80	50	5-20
NM	2,300	Alternaria Leaf Spot			50 Total	5-15	
		Downy Mildew	Chlorothalonil	2	25		0-5
			Metalaxyl	2	25		0-5
			Maneb	2	25		0-5
			Mancozeb	2	25		0-5
		Powdery Mildew			50 Total		5-15
			Triadimefon	2	50		0-5
			Benomyl	2	50		0-5
		Fruit Rots	Copper	1-2	50	5	0-5

CUCURBITS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
ND	135	Anthracnose			100 Total	25-30	
			Chlorothalonil	4-6	40		5-10
			Mancozeb	4-6	60		5-10
OK	28,000	Downy Mildew					
			Chlorothalonil and Metalaxyl	3	95	50	<5
		Anthracnose			100 Total	75	
			Triadimefon	3	10		10
			Chlorothalonil	3	80		30
			Mancozeb	3	10		40
		Alternaria Leaf Spot (Squash Only, 2,000 Acres)			10 Total	80	
			Chlorothalonil	5	50		25
			Mancozeb	5	50		25
		Powdery Mildew	Triadimefon	3	90	60	<5
		Damping Off	Thiram (Seed)	1	100	5	3
		Pythium Cottony Leak	Metalaxyl	1	10	4	<1

CUCURBITS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
SD	1,200	Anthracnose Alternaria Powdery Mildew Downy Mildew	Chlorothalonil	4-5	50 Total	5-10	0-5
TX	23,000	Powdery Mildew			60-80 Total	5-20	
			Triadimefon	2-6	50		0-5
			Benomyl	2-6	50		0-5
		Downy Mildew			50-80 Total	20	
			Maneb	2-6	25		0-5
			Mancozeb	2-6	25		0-5
			Chlorothalonil	2-6	25		0-5
			Anilazine	2-6	25		0-5
		Anthracnose			50-80 Total	10-25	
			Chlorothalonil	2-4	20		0-5
			Benomyl	2-4	20		0-5
			Maneb	2-4	30		0-5
			Mancozeb	2-4	30		0-5
		Gummy Stem Blight			50-80 Total	20	
			Chlorothalonil	2-4	25		5-15
			Maneb	2-4	25		5-15
			Mancozeb	2-4	25		5-15
			Benomyl	2-4	25		5-15
		Alternaria			50-80 Total	10-20	
			Maneb	2-6	50		0-5
			Mancozeb	2-6	50		0-5

EGGPLANT

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
LA	100	Phomopsis Fruit Rot	Maneb and Zinc	1-2	5	10	0-5

GARLIC

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
CA	13,000	White Rot	Iprodione	1	<2	<0.5	0.1
NV	1,200	White Rot Fusarium	Methyl Bromide	1	+50	25	0-5
OR	2,000	Botrytis	Mancozeb	4-5	20-50 Total	5-10	
			Chlorothalonil	2	50	0-5	
					50	0-5	

LENTILS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
ID	23,000	Root Rot	Captan (Seed)	1	100	5-10	0-2

LETTUCE

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
AZ	49,000	Drop			30 Total	4	
			Iprodione	2	50		1-3
			Vinclozolin	2	50		1-3
		Rhizoctonia			30 Total	5	
			Iprodione	2	50		0-2
			Vinclozolin	2	50		0-2
		Downy Mildew	Maneb	1	30 Total	1	0.1
CA	160,000	Drop			80 Total	20	
			Dicloran	1	50		7-12
			Vinclozolin	1-2	30		5-10
			Iprodione	1-2	20		5-10
		Downy Mildew			50-60 Total	10-20	
			Maneb	2-3	70		0-5
			Metalaxyl	2-3	25		0-20
			Aliette	2-3	5		0-15
CO	3,000	Damping Off	Thiram (Seed)	1	100	10	0-2
		Downy Mildew, Botrytis	Maneb	3-5	75 Total 100	10	0-5
		Drop	Vinclozolin	1-2	75 Total	10	2-5
HI	510	Downy Mildew			100 Total	80	
		Cercospora	Botran	3			
		Rhizoctonia	Folpet	3			
		Pythium	Maneb	3			
		Septoria	Iprodione	3			
			Metalaxyl	3			
			Copper	3			
NM	2,800	Downy Mildew			10 Total	2	
			Maneb	1	100		0-1
		Rhizoctonia			10 Total	1	
			Iprodione	1	50		0-1
			Copper	1	50		0-1
TX	2,000	Drop	Iprodione	1-2	30-70	20	5-10
		Downy Mildew			50-70 Total	10-20	
			Maneb	2-5	100		0-5

ONIONS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
CA	37,000						
		Downy Mildew			30-40 Total	5-10	
			Maneb	2-4	15		0-5
			Mancozeb	2-4	50		0-5
			Metalaxyl and Mancozeb	2-4	30		0-3
			Copper	2-4	5		0-10
			Chlorothalonil	2-4	10		0-8
		Purple Blotch, Botrytis			<20 Total	<5	
			Chlorothalonil	1-3	24		0-3
			Mancozeb	1-3	65		0-3
			Maneb	1-3	4		0-3
			Iprodione	1-3	4		0-3
			Copper	1-3	3		0-5
CO	12,000	Purple Blotch Downy Mildew			90 Total	15	
			Maneb	3-7	25		0-5
			Mancozeb	3-7	25		0-5
			Chlorothalonil	3-7	25		2-7
			Iprodione	3-7	20		0-5
			Copper	3-7	5		0-10
		Damping Off			90-100 Total	5	
			Thiram (Seed)	1	50		0-2
			Captan (Seed)	1	50		0-2
HI	320	Purple Blotch Botrytis Downy Mildew			100 Total	80	
			Chlorothalonil	4			
			Maneb	4			
			Mancozeb	4			
			Copper	4			
			Metalaxyl	4			
			Iprodione	4			
			Folpet	4			
ID	2,000	Purple Blotch, Botrytis			100 Total	20	
			Chlorothalonil	2	40		5-10
			Mancozeb	2	30		0-5
			Iprodione	2	30		0-5
		Downy Mildew			100 Total	20	
			Mancozeb	2	70		0-5
			Chlorothalonil	2	20		0-10
			Iprodione	2	10		0-5

ONIONS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
MN	1,000	Downy Mildew	Chlorothalonil	2-4	50		
NB	2,000	Purple Blotch, Botrytis			95 Total	70-80	
			Chlorothalonil	3-6	40		15-25
			Iprodione	3-6	20		5-15
			Mancozeb	3-6	40		10-20
NV	630	Fusarium	Chloropicrin	1	50	20	0-5
NM	6,400	Purple Blotch			20 Total	5	
			Anilazine	1	15		0-2
			Iprodione	1	25		0-2
			Maneb	1	25		0-2
			Mancozeb	1	25		0-2
			Copper	1	10		0-5
OR	14,000	Downy Mildew			50 Total	5	
			Chlorothalonil	2	30		0-5
			Mancozeb	4-5	70		0-2
TX	19,600	Downy Mildew			100 Total	20-50	
			Maneb	3-7	25		0-5
			Mancozeb	3-7	25		0-5
			Chlorothalonil	3-7	25		0-10
			Metalaxyl and Mancozeb	3-7	25		0-2
		Purple Blotch, Botrytis			100 Total	10-30	
			Chlorothalonil	3-7	30		0-5
			Maneb	3-7	30		0-5
			Mancozeb	3-7	30		0-5
			Anilazine	3-7	10		0-5
UT	1,900	Purple Blotch, Botrytis	Chlorothalonil	1	10	2-5	0-2
WA	3,400	Downy Mildew			35 Total	<10	
			Metalaxyl and Chlorothalonil	2-6	25		<1
			Mancozeb	2-6	75		<1
		Purple Blotch			50 Total	<10	
			Mancozeb	2-4	35		<1
			Chlorothalonil	2-4	20		<1
			Metalaxyl	2-4	20		<1
			Iprodione	2-4	25		<1
		White Rot			10 Total	20	
			Vinclozolin	1	50		5
			Dicloran	1	50		10-15

PEAS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
CA	10,000	Powdery Mildew			<5 Total	<1	
			Sulphur	1-2	60		0-0.1
			Copper	1-2	40		0-0.1
		Root Rot (Pythium)	Iprodione	1	<1 Total	<0.1	0-0.05
ID	104,000	Damping Off, Root Rots			100	15	
			Captan (Seed)	1	80		0-10
			Metalaxyl (Seed)	1	20		0-5
LA	3,000	Cercospora Other Leaf Spots	Mancozeb	1	5	2	0-2
WA	80,000	Damping Off	Captan (Seed)	1	100	10-15	
			Metalaxyl (Seed)	1	44		
		Downy Mildew	Metalaxyl (Soil)	1	2-4	1-2	

PEPPERS

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
AR	180	Spot Speck Canker			0-40 Total	0-60	
		Alternaria					
			Copper	0-3	100		0-20
CA	12,000	Root Rot	Metalaxyl	1	2-5	2	0-1
HI	170	Cercospora			100 Total	50	
		Alternaria	Maneb	3			
		Botrytis					
		Colletotrichum	Copper	3			
		Pythium					
		Phytophthora					
		Phoma					
LA	1,500	Bacterial Spot			80 Total	50	
			Copper	3-4			10-25
			Maneb	3-4	10-25		
NM	22,210						
		Rhizoctonia	Captan (Seed)	1	20	5	0-2
		Bacterial Spot	Copper	1-3	20	1	0-1
		Cercospora Leaf Spot			20 Total	1	
			Maneb	1-3	100		0-1
OK	1,500	Bacterial Spot	Copper	4	75	50	20

POTATOES

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
CA	42,000	Early Blight			90 Total	10-40	
			Chlorothalonil	2-4	20		0-2
			Mancozeb	2-4	40		0-2
			Maneb	2-4	40		0-2
		Late Blight			<10 Total	<2	
			Chlorothalonil	2-3	15		0-1
			Mancozeb	2-3	20		0-1
			Maneb	2-3	10		0-1
			Chlorothalonil and Metalaxyl	2-3	25		0-1
		White Mold			<5 Total	<1	
			Dicloran	1-2	50		0-0.1
			Iprodione	1-2	50		0-0.1
		Seed Piece Decay			50-100 Total	5-10	
			Thiophanate methyl (Seed)	1	40		0-2
			Thiabendazole (Seed)	1	40		0-2
			Captan (Seed)	1	20		0-2
ID	350,000	Seed Piece Decay			100 Total	10-20	
			Thiophanate methyl (Seed)	1	25		0-2
			Thiabendazole (Seed)	1	25		0-2
			Captan (Seed)	1	25		0-2
		Early Blight			80 Total	10-40	
			Mancozeb	2	40		0-5
			Chlorothalonil	2	40		0-5
			Triphenyltin Hydroxide	2	20		0-5

POTATOES

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
IA	500	Early Blight			100 Total	30	
			Mancozeb	3-6	25		0-5
			Maneb	3-6	25		0-5
			Chlorothalonil	3-6	25		0-5
			Benomyl	3-6	25		0-5
		Late Blight			100 Total	5-30	
			Metalaxyl and Chlorothalonil	3-6	50		0-5
			Metalaxyl and Mancozeb	3-6	50		0-5
KS	1,000	Early Blight			50 Total	5	
			Mancozeb	1-2	60		0-2
			Chlorothalonil	1-2	40		0-2
MN	74,000	Early Blight			60 Total		
			Mancozeb	2-4	70		
			Chlorothalonil	2-4	30		
		Late Blight			80 Total		
			Mancozeb	2-4	70		
			Chlorothalonil	2-4	30		
		Seed Piece Decay	Thiophanate Methyl (Seed)	1	50		
MO	3,000	Early Blight			100 Total	25-50	
			Mancozeb	2-3	50		0-5
			Maneb	2-3	50		0-5
MT	6,000	Early Blight			17.5 Total	<1	
			Benomyl	1-2	50		0-0.1
			Triphenyltin Hydroxide	1-2	50		0-0.1
NV	8,000	White Mold	Iprodione	1-2	10		0-1
		Early Blight Late Blight			80 Total	10-20	
			Maneb	2-4	10		0-10
			Chlorothalonil	2-4	90		0-5

POTATOES

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Specific Fungicides
ND	130,000	Early Blight			66 Total	5	
			Mancozeb	3-4	30		0-2
			Maneb	3-4	30		0-2
			Metiram	3-4	20		0-2
			Triphenyltin Hydroxide	1-2	20		0-2
OK	5,000	Early Blight			80 Total	80	
			Maneb	6	50		20
			Chlorothalonil	6	50		10
		Late Blight	Metalaxyl and Chlorothalonil	3	80	80	10
		Seed Piece Decay			70 Total	3-5	
			Thiram (Seed)	1	33		3
			Thiabendazole	1	33		3
			Thiophanate methyl	1	33		3
OR	52,000	Early Blight, Late Blight			70-90 Total	10-40	
			Chlorothalonil	2-4	50	0-5	
			Mancozeb	2-4	50		0-5
		Sclerotinia	Iprodione	1-2	5-10	<2	0-1
WA	120,000	Late Blight			75 Total	10	
			Metalaxyl and Mancozeb	3-5	30		<1
			Metalaxyl and Chlorothalonil	3-5	25		<1
			Mancozeb or Maneb	3-5	40		<1
		Early Blight			75 Total	10	
			Mancozeb or Maneb	3-5	40		<5
			Chlorothalonil	3-5	25		<5
			Metalaxyl and Mancozeb	3-5	15		<5
			Metalaxyl and Chlorothalonil	3-5	15		<5
		White Mold	Chlorothalonil	3-5	20		
		Seed Piece Decay	Thiophanate methyl	1	80	2-5	2-5
UT	6,700						
		Seed Piece Decay			85 Total	3-5	
			Captan (Seed)	1	20		0-1
			Mancozeb (Seed)	1	20		0-1
			Thiabendazole (Seed)	1	30		0-1
			Thiophanate methyl (Seed)	1	30		0-1
		Early Blight			65 Total	5-20	
			Mancozeb	1-2	50		0-5
			Maneb	1-2	50		0-5

SPINACH

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
AR	900	Downy Mildew			30-90 Total	25-100	
		White Rust	Maneb	2-4	70		5-20
			Metalaxyl	1-3	30		5-50
		Anthracnose	Maneb	2-4	30-90 Total	25-100	5-15
CA	10,000	Downy Mildew	Maneb	1-2	100 Total	20-60	5-50
OK	1,000	White Rust			100 Total	60	
			Maneb	5			20
			Metalaxyl	3			<5
TX		Downy Mildew,			30-90 Total	10-50	
		White Rust	Maneb	2-4	70		5-20
			Metalaxyl	1-3	30		5-30
		Anthracnose	Maneb	2-4	30-90 Total	25-50	0-10
UT	75	Downy Mildew			50 Total	10-20	
			Zineb	1	50		0-10
			Ziram	1	50		0-10

SWEET CORN

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
CA	11,000	Damping Off			100 Total	5-20	
			Thiram (Seed)	1	20		0-10
			Captan (Seed)	1	80		0-10
			Imazalil (Seed)	1	10		0-5
CO	4,000	Pythium, Fusarium, Rhizoctonia, Penicillium			90 Total		10
			Captan (Seed)	1	40		0-5
			Thiram (Seed)	1	40		0-5
			Carboxin (Seed)	1	20		0-2
HI	185	Leaf Blights			10 Total	20	
		Rust	Maneb	1			
		Pythium	Mancozeb	1			
		Rhizoctonia	Chlorothalonil	1			
			Metalaxyl	1			
ID (Seed)	12,000	Damping Off			100 Total	30	
		Head Smut	Captan (Seed)	1	50		0-5
			Thiram (Seed)	1	50		0-5
			Benomyl (Seed)	1	<20		0-5
			Imazalil (Seed)	1	20		0-5
			Metalaxyl (Seed)	1	20		0-5
			Carboxin (Seed)	1	20		0-5
ID	18,800	Damping Off			100	35	
			Captan (Seed)	1	50		0-5
			Thiram (Seed)	1	50		0-5
			Benomyl (Seed)	1	5		0-5
			Imazalil (Seed)	1	5		0-5
			Metalaxyl (Seed)	1	10		0-5
			Carboxin (Seed)	1	5		0-5

SWEET CORN

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
IA	7,000	Damping Off	Captan (Seed)	1	100	5-10	0-5
MN	130,000	Rust	Mancozeb	2-3	60-75	50-75	
		Damping Off			100 Total	5-10	
			Captan (Seed)	1			
			Thiram (Seed)	1			
ND	120	Rust	Mancozeb (Seed)	1	10	1-2	0-1
OK	750	Damping Off			100 Total	5-10	
			Thiram (Seed)	1	70		0-5
			Captan (Seed)	1	30		0-5
TX	3,100	Damping Off			100 Total	5	
			Captan (Seed)	1	50		0-5
			Thiram (Seed)	1	50		0-5

SWEET POTATO

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
CA	6,500	Seed Piece Decay	Dicloran (Seed)	1	75	5-10	0-5
		Stem Rot	Benomyl (Seed)	1	40	5	0-5
		Rhizopus	Dicloran (Seed)	1	90	5-30	0-5
LA	22,000	Scurf			90 Total	20	
		Southern Blight	Dicloran	1	50		2-10
		Black Rot	Mertect		50		2-10

TOMATOES

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
AR	3,000	Alternaria, Septoria			90 Total	5-60	
			Chlorothalonil	3-8	50		0-20
			Mancozeb	3-8	50		0-20
CA	240,000	Alternaria			15-25 Total	5-15	
			Chlorothalonil	1-3	17		3-10
			Mancozeb	1-3	65		3-10
			Anilazine	1-3	17		3-10
		Late Blight	Chlorothalonil and Metalaxyl	1-2	<2	<2	<1
		Phytophthora Root Rot	Metalaxyl	1-2	<1	<1	<0.1
		Powdery Mildew			20 Total	<5	
			Triadimefon	1-2	20		4-5
			Sulphur	1-2	<0.1		0-<1
		Pseudomonas	Copper	1-2	1	<1	<0.1
CO	1,000	Damping Off, Rhizoctonia			100	5	
			Captan (Seed)	1	50		0-2
			Thiram (Seed)	1	50		0-2
		Alternaria, Colletotrichum			90 Total	20	
			Maneb	3-5	25		0-10
			Chlorothalonil	3-5	25		0-10
			Benomyl	3-5	25		0-10
			Mancozeb	3-5	25		0-10
		Pseudomonas	Copper	1-3	50-90	5	0-2
HI	250	Alternaria			100 Total	90	
		Botrytis	Chlorothalonil	5			
		Anthracnose	Metalaxyl				
		Pythium	Maneb	5			
		Phytophthora	Benomyl	5			
		Septoria	PCNB	5			
		Stemphylium	Mancozeb	5			
		Sclerotium					

TOMATOES

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
IA	1,200	Early Blight			100 Total	30-40	
		Septoria, Anthracnose	Chlorothalonil	1-2	33		0-10
			Maneb	1-2	33		0-10
			Mancozeb	1-2	33		0-10
KS	5,500	Early Blight, Septoria			100 Total	20	
			Chlorothalonil	5-7	30		0-5
			Mancozeb	5-7	70		0-5
		Bacterial Speck	Copper	2-5	100	20	0-10
LA	600	Early Blight			100 Total	35	
		Gray Blight	Mancozeb	6-8			
		Bacterial Spot	Chlorothalonil	6-8			
		Buckeye Rot	Metalaxyl				
		Sclerotinia	Benomyl	6-8			
			Copper and Mancozeb	6-8			
MO	500	Early Blight			100 Total	50	
			Mancozeb	2-5	50		0-10
			Maneb	2-5	50		0-10
OK	1,000	Early Blight			100 Total	80	
			Mancozeb	6	60		20
			Chlorothalonil	4	40		20
		Spot	Copper	5	40	32	12
		Late Blight	Metalaxyl and Chlorothalonil	2	20	10	2-5
		Septoria			10 Total	2	
			Mancozeb	1-2	50		0-1
			Chlorothalonil	1-2	50		0-1

TOMATOES

State	Acres	Disease	Chemical	No. of Applications	% Acres Treated	% Yield Loss w/o Fungicides	Expected Loss Using Specific Fungicides
TX	4,000	Colletotrichum,			100 Total	30-60	
		Alternaria,	Anilazine	3-8	5		5-10
		Septoria,	Benomyl	3-8	5		5-10
		Early and Late Blight	Chlorothalonil	3-8	20		5-10
		Pseudomonas	Copper	3-8	5		10-15
			Mancozeb	3-8	25		5-10
			Maneb	3-8	15		5-10
			Metalaxyl and Mancozeb	3-8	25		2-5
UT	500	Powdery Mildew	Sulphur	2	30	10-30	0-10

Summary

Asparagus - Loss of fungicides would not have a great impact on asparagus production in California where the dry climate limits foliar diseases but may negatively affect Washington's crop. Mancozeb is the only material used for the control of rust in Washington; no other control measure exists. Perhaps the most important disease of asparagus is Fusarium crown rot which is generally controlled by crop rotation, and the use of disease-free planting stock. In the state of Washington, however, the use of benomyl for controlling Fusarium is critical for optimum production.

Beans - The use of fungicides is the only means of controlling certain foliar diseases and fungi that destroy bean seeds or seedlings soon after planting. Replacing fungicides as seed treatments with biocontrol agents such Trichoderma or antagonistic bacteria is a very active area of research in plant pathology institutions all over the world. But at present, nothing offers the consistent control of fungicides. Replacing fungicides on bean seeds may become a reality, at least in part in the next 5-10 years, but I see little hope for eliminating the need to use fungicides for controlling bean foliar diseases in the foreseeable future.

Carrots - Almost all carrots grown in the western United States require fungicide treatments for optimum productivity. Without fungicides, carrot yields would be reduced 10-40%. There are no alternative methods of controlling foliar diseases which are common wherever carrots are grown.

Celery - Only California and Texas reported celery production. All acreage is treated with fungicides; the losses to production if fungicides were not available would be very high. In California up to 50% of the crop would be lost, and in Texas production may not be possible.

Crucifers - Foliar diseases of crucifers are serious in all western states, and most of the acreage is treated. Without the use of fungicide, losses would range from about 15-50%. There are no alternative control measures. The elimination of maneb and mancozeb would limit the chemical choices for controlling downy mildew to chlorothalonil and metalaxyl.

Cucurbits - Almost all cucurbit acreage in the west is treated with fungicides; several applications are often required for good disease control. Although the EBDC's are often the materials of choice given their broad spectrum of activity and relative low cost, several other alternative fungicides are used. Without the use of any fungicides, cucurbit production would be significantly reduced. There are no

alternative methods of controlling most cucurbit diseases.

Garlic - Generally requires very little fungicide input for maximum production.

Lettuce - Fungicides are important for the control of downy mildew and drop. Without EBDC's, control of downy mildew is tenuous since resistant strains of the fungus have developed against metalaxyl, and in general, no other fungicides are registered. Loss of fungicide registration will result in significant crop loss.

Onion - Most onion acreage is treated with fungicides. There is no resistance against downy mildew, purple blotch, or Botrytis, and loss of the use of fungicides would significantly reduce onion production. EBDC's are often the materials of choice due to their efficacy and relative low cost.

Peas - Fungicide seed treatments are important in reducing losses to soilborne diseases. Almost all seed is treated, and losses would be substantial without chemicals. Foliar diseases are not important in the west due to the dry climate.

Peppers - Most of the pepper production in the West is in California and New Mexico where the dry climate limits the importance of foliar diseases. In California no fungicides are applied to the foliage; in New Mexico 20% of the acreage receives fungicides. Without the use of any fungicides, there will be little overall loss in production.

Potatoes - Potatoes grown in all states require fungicides for optimum production. Losses to 40% may occur if fungicides are not available. Early blight is the most important disease; there are no alternative control measures as effective as fungicides.

Spinach - Downy mildew and/or white rust requires chemical control in all production states for maximum yields. Yield losses would be substantial without the use of fungicides. Maneb is the important chemical; its loss creates a serious vacuum in spinach culture. New races of the downy mildew fungus preclude the use of resistant varieties. Therefore, the availability of fungicides is absolutely necessary.

Sweet corn - All seed is treated with fungicides to prevent damping-off. Foliar fungicides are rarely used.

Sweet potatoes - Fungicides applied to seed pieces or at bedding are important for optimum yields. No foliar fungicides are used.

Tomatoes - Tomatoes are one of the largest users of fungicides. Many fungi cause a variety of leaf spots and blights that can significantly reduce yields when fungicides are not used. There are no alternatives to the control of most of these diseases. The EBDC fungicides are often the materials of choice due to their relative low cost.